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Description

PROBE SHEET AND PROBE SHEET UNIT USING SAME

BACKGROUND OF THE INVENTION

FIELD OF THE INVENTION

[0001] The present invention relates to a probe sheet used in measurement of electric characteristics of a measurement objective and a probe sheet unit using the same.

PRIOR ART

[0002] There has been available a probe card having a sheet member made of a Teflon(a registered trade mark)-based insulating film and projected probes provided on a surface of the sheet member (see Patent literature 1).

[0003] Patent literature 1 is JP-A No. 8-122364.

[0004] A measurement objective in the recent years has been advanced in complexity in an integrated circuit thereof and electrodes thereof have been increasingly miniaturized. With such a high complexity in integrated circuit of a

measurement objective, a dispersion in height of electrodes, though extremely low, is revealed. The dispersion in height of electrodes of a measurement objective is further deteriorated due to global inclination and bending of the measurement objective. Therefore, in a case where an electric characteristic of a measurement objective is measured using the probe sheet unit, part of the probes are brought into no contact with corresponding electrodes, leading to an essential problem of disabling correct measurement.

[0005] The advancement in complexity in an integrated circuit of a measurement objective entails miniaturization of probes and a smaller pitch between the electrodes, thereby revealing a dispersion in height of probes, though extremely low. The dispersion is further deteriorated by inclination and bending of a probe sheet occurring when the probe sheet is mounted to a prober. In this case as well, part of the probes is not brought into contact with corresponding electrodes, leading to a problem of disabling correct measurement.

[0006] In a case where measurement is conducted at temperatures in a wide range (for example, in the range of from 150°C to -40°C), a measurement objective and a sheet

member expand or shrink by a change in temperature independently to each other and thereby, inclination and bending similar to the above described occur, which causes a dispersion in height of electrodes and a dispersion in height of probes to be deteriorated and in addition, also results in a positional shift between an electrode, which is a measurement objective, and a probe. Hence, a problem similar to that described above occurs.

SUMMARY OF THE INVENTION

[0007] The present invention has been made in light of the above circumstances and it is an object of the present invention to provide a probe sheet capable of achieving correct measurement independently of a dispersion in height of electrodes of a measurement objective; and a probe sheet unit using the same.

[0008] In order to solve the above problems, a probe sheet of the present invention includes a sheet member having a flexibility and plural probes for measurement provided on one surface of the sheet member, wherein a probe has a shape capable of elastic deformation in a direction, upward or downward.

[0009] Wiring patterns are formed inside and/or on a surface of the sheet member and an external electrode connected

electrically to the probes through the wiring patterns is provided on a surface of the sheet member.

[0010] Circuit elements are provided inside and/or on a surface of the sheet member and the circuit elements are connected electrically to the wiring patterns.

[0011] In a case where a probe is curved and supported at one end thereof, a reinforcing member with an elasticity higher than the probe may be provided integrally with the probe on a surface thereof opposite the sheet member along the length direction. In a case where the probe is curved and there is a predetermined clearance between a surface of the probe on the other side of the probe from the top of the probe at which the probe is brought into contact with an electrode of a measurement objective and the sheet member, a reinforcing member with an elasticity higher than the probe is inserted in the clearance.

[0012] The sheet member is desirably made of a material of a linear expansion coefficient in the range of 2.5 to 10.5 ppm/°C.

[0013] A probe sheet unit of the present invention is a sensing section of a semiconductor wafer measuring instrument and includes: a base plate mounted to a prober of the instrument; the probe sheet mounted to a lower surface of

the base plate; and an elastic member interposed between the base plate and the probe sheet.

[0014] In a case where a probe sheet related to Claim 1 of the present invention is adopted, probes and a sheet member are elastically deformed independently or together with each other, thereby enabling adaptation for a dispersion in height of electrode of a measurement objective and/or a dispersion in height of the probes. Therefore, since there is no chance that part of the probes is not brought into contact with the corresponding electrodes, which has occurred in a conventional example, thereby enabling correct measurement.

[0015] In a case where a probe sheet related to Claim 2 of the present invention is adopted, wiring patterns are formed inside and/or on a surface of a sheet member and provided on a surface of the sheet member is an external electrode connected electrically to the probes through the wiring patterns, thereby enabling an electrical connection to a measuring instrument with ease.

[0016] In a case where a probe sheet related to Claim 3 of the present invention is adopted, circuit elements necessary for electrical measurement with the probes are disposed at positions close to the probes; therefore, enjoying a

merit of improvement on a measurement precision.

[0017] In a case where a probe sheet related to Claim 4 of the present invention is adopted, a reinforcing member with an elasticity higher than a probe is provided integrally with the probe along the length direction, thereby enabling a strength of the probe to be enhanced.

[0018] In a case where a probe sheet related to Claim 5 of the present invention is adopted, a reinforcing member with an elasticity higher than a probe is provided in a clearance between a surface of the probe on the other side of the probe from the top of the probe and a sheet member; thereby enabling a strength of the probe to be enhanced.

[0019] In a case where a probe sheet related to Claim 6 of the present invention is adopted, the sheet member is made of a material of a linear expansion coefficient in the range of 2.5 to 10.5 ppm/°C. That is, the sheet member is made of a material with the same linear expansion coefficient as a measuring objective; therefore, the sheet member deforms in the same way as the measurement objective, by a change in temperature in a measurement environment. Therefore, probes formed on the sheet member can follow up positional shifts of corresponding electrodes accompanying deformation of the measurement objective.

[0020] In a case where a probe sheet unit related to Claim 7 of the present invention is adopted, an elastic member pushes a deformed sheet member so as to return to an original state thereof while absorbing elastic deformation of a sheet member, therefore enabling adaptation for a dispersion in height of electrodes and/or a dispersion in height of probes with more flexibility.

BRIEF DESCRIPTION OF THE DRAWINGS

[0021] Fig. 1 is a schematic sectional view of a probe sheet unit related to an embodiment of the present invention;

[0022] Fig. 2 is a schematic sectional view showing part of a probe sheet having a sheet member made of one sheet of the unit;

[0023] Fig. 3 is a schematic sectional view showing part of a probe sheet having a sheet member formed by laminating plural sheets of the unit;

[0024] Fig. 4 is model views for describing other probes used in the unit;

[0025] Fig. 5 is model views for describing a reinforcing member for a probe;

[0026] Fig. 6 is a schematic sectional view showing a state where a probe of the unit is in contact with an electrode of a measurement objective; and

[0027] Fig. 7 is a schematic sectional view of another probe sheet unit.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0028] Description will be given of a probe sheet unit related to an embodiment of the present invention below with reference to the accompanying drawings. Fig. 1 is a schematic sectional view of a probe sheet unit related to the embodiment of the present invention, Fig. 2 is a schematic sectional view showing part of a probe sheet having a sheet member made of one sheet of the unit, Fig. 3 is a schematic sectional view showing part of a probe sheet having a sheet member formed by laminating plural sheets of the unit, Fig. 4 is a model views for describing other probes used in the unit, Fig. 5 is model views for describing a reinforcing member for a probe, Fig. 6 is a schematic sectional view showing a state where a probe of the unit is in contact with an electrode of a measurement objective and Fig. 7 is a schematic sectional view of another probe sheet unit.

[0029] A probe sheet unit A shown in Fig. 1 is a sensing section of a measuring instrument (not shown) for a measurement objective B and includes: a base plate 100 mounted to a prober of the instrument; and a probe sheet 200 mounted

to a lower surface of the base plate 100. Detailed description will be given of constituents of the instrument below.

[0030] The probe sheet 200 includes: a sheet member 210 having a flexibility; and plural probes 220 for measurement provided on one surface of the sheet member 210. The sheet member 210 has a flexibility and is made of a material with a linear expansion coefficient in the range of from 2.5 to 10.5 ppm/°C. Examples thereof include a single insulating sheet made of silicon, a single insulating sheet made of a plastic, a sheet formed by laminating plural insulating sheets made of silicon, a sheet formed by laminating plural insulating sheets made of a plastic, and the like.

[0031] That is, by using a material with the same linear expansion coefficient as or a linear expansion coefficient similar to that of the measurement objective B, the sheet member 210 can be expanded or shrunk in a similar way to that the measurement objective B is expanded or shrunk. With such a material employed, the probes 220 formed on a surface of the sheet member 210 can follow up positional shifts of corresponding electrodes accompanying expansion or shrinkage of the measurement objective B.

[0032] The reason why a linear expansion coefficient of the sheet

member 210 is set in the range of from 2.5 to 10.5 ppm/°C is as follows: First of all, since almost all of measurement objectives B are of a size in the range of from 10 × 10 mm to 300 × 300 mm, if a material of the measurement objectives B is silicon, a linear expansion coefficient is 2.5 ppm/°C, and a relative positional shift between a measurement objective B and the sheet member 210 is confined to 10 μm or less under a condition that a measurement environment temperature is in the range of from ordinary temperature (25°C) to 150°C, a linear expansion coefficient of the sheet member 210 in a case where a size of a measurement objective B is 10 × 10 mm and a linear expansion coefficient of the sheet member 210 in a case where a size of a measurement objective B is 300 × 300 mm are obtained in ways described below:

[0033] In the case where a size of a measurement objective B is 10 × 10 mm,

[0034] [Formula 1]

[0035] $10\ \text{mm} \times X \times (150°\text{C} - 25°\text{C}) = 10\ \mu\text{m}$

[0036] $X = 8\ \text{ppm}/°\text{C}$

[0037] In the case where a size of a measurement objective B is 300 × 300 mm,

[0038] [Formula 2]

[0039] $300\ \mathrm{mm} \times X \times (150°C - 25°C) = 10\ \mu m$

[0040] $X = 0.27\ \mathrm{ppm}/°C$

[0041] In consideration of a fact that the measurement objective B also expands with heat at the same time that the sheet member 210 expands with heat, a linear expansion coefficient of 2.5 ppm/°C of the measurement objective B is added respectively to the linear expansion coefficient 8 ppm/°C in the case where a size of a measurement objective B is 10 × 10 mm and to the linear expansion coefficient 0.27 ppm/°C in the case where a size of a measurement objective B is 300 × 300 mm. Then, the former takes 10.5 ppm/°C and the latter takes 2.77 ppm/°C. That is, by using a material of a linear expansion coefficient in the range of from 2.77 to 10.5 ppm/°C as a material of the sheet member 210, a sheet member can be adapted for an expansion coefficient of almost all measurement objectives, while with consideration given to a technique that silicon same as the measurement objective B is used as a material of the sheet member 210, a linear expansion coefficient of the sheet member 210 is set in the range of from 2.5 to 10.5 ppm/°C.

[0042] In a case where a sheet member 210 is made of one sheet, as shown in Figs. 1 and 2, wiring patterns 211 is provided on one surface thereof and an external electrode 212 is provided on the other surface thereof at the edge. The external electrode 212 and the probes 220 are connected electrically to each other through the wiring patterns 211.

[0043] Circuit elements 213 connected electrically to the wiring patterns 211 are provided on the one surface of the sheet member 210. A circuit element 213 is an element necessary to conduct electric measurement with a probe and, in this case, includes a capacitor functioning as a so-called pass capacitor and a circuit element functioning as a BOST (built out self test) circuit assisting a test (that is, measurement of an electric characteristic of a measurement objective B). The capacitor plays a role to improve high frequency characteristics. The circuit element functioning as a BOST circuit plays a role that alters according to contents of a test on a measurement objective B.

[0044] On the other hand, in a case where a sheet member 210 is formed by laminating plural sheets, as shown in Figs. 1 and 3, plural wiring patterns 211 are formed on one surfaces of respective sheets and an external electrode 212 is

provided on the other surface of the sheet member 210 at the edge thereof. The wiring patterns 211 in each sheet and the lower sheet thereof are connected electrically to each other. The external electrode 212 and the probes 220 are connected electrically to each other through the wiring patterns 211. Circuit elements 213 described above are also provided on each sheet of the sheet member 210.

[0045] The probe 220 is formed on one surface of the sheet member 210 integrally with the one surface thereof in a procedure in which a resist is coated on the one surface of the sheet member 210 to form patterns on the resist and to plate the one surface thereof in conformity with the patterns, and such a process is repeated. Note that a pitch of the probes 220 is the same as that of electrodes 10 of a measurement objective B so that the probes 220 can be brought into contact with the corresponding electrodes 10 of the measurement object B and in this case, the pitch is set at 25 μm.

[0046] Each of the probes 220 has a shape capable of elastic de-formation at least in a direction, upward or downward, for absorbing a dispersion in height of the electrodes 10 of the contactable measurement objective B. Examples of probes 220 include, as shown in Figs. 2 and 3, one

formed on the one surface of the sheet member 210, in the shape of a half-circle arc and with one end thereof being supported by the sheet member 210; as shown in Fig. 4(a), one in the shape of a circle arc, and with both ends thereof connected the sheet member 210; as shown in Fig. 4(b), one, one end of which supported by the sheet member 210, and having plural curved portions in the length direction of the sheet member 210; as shown in Fig. 4(c), one in the shape of a circle, and with both ends thereof connected to the sheet member 210; as shown in Fig. 4(d), one, one of which is supported by the sheet member 210, and having plural curved portions; as shown in Fig. 4(e), one, one end of which is supported by the sheet member 210 and having one curved portion in the length direction of the sheet member 210; as shown in Fig. 4(f), one in the shape of a coil spring; and others. A contact terminal 223 as a projection, which is brought into contact with the electrode 10 of the measurement objective B, can be provided at the top of the probe 220 located at almost the center thereof. For convenience of explanation, with respect to the probe 220, description will be given of a probe which is in the shape of a half-circle arc and with one end thereof being supported as

shown in Figs. 2 and 3, as an example.

[0047] A probe 220 has a shape including a first quarter circle arc portion 221 one end of which is supported by the sheet member 210 and a second quarter circle arc portion 222, which is connected to the other end of the first quarter circle arc portion 221 and a little shorter than the first quarter circle arc portion 221. A contact terminal 223 as a projection is provided at the top of the probe 220 located at almost the center thereof.

[0048] A probe 220 can also be of a structure in which as shown with oblique hatching in Fig. 5(a), a reinforcing member 230 made of alumina with an elasticity higher than the probe 220, in the fabrication process, is formed integrally with the probe 220, along the length direction, on the surface of the probe 220 opposite the sheet member 210. The reinforcing member 230 can also made as plural layers. In a case where a probe 220 brought into contact with an electrode 10 of the measurement objective B is, as shown with oblique hatching in Fig. 5(b), curved and has a clearance between a surface on the other side of the probe 220 from the top thereof and the sheet member 210, a reinforcing member 230 such as an elastomer with an elasticity higher than the probe 220 may be interposed

in the clearance. The reinforcing member 230 as an elastomer is interposed in the clearance in a fabrication process of the probes 220.

[0049] Used as the base plate 100 is PCB on which a wiring pattern (not shown) is formed for electrical connection to the prober. The wiring pattern is connected to electrically to the external electrode 212 on the sheet member 210. The sheet member 210 is mounted to the base plate 100 by adhesion, compression bonding or the like so as to assume a shape of almost an inverse Greek Π with a flange at the top opening thereof. In the course of the mounting, an elastic member 300 is inserted between the base plate 100 and the sheet member 210.

[0050] Employed as the elastic member 300 are an elastic resin such as rubber, a bag filled with water or air, a spring, or the like. The elastic member 300 out of operation pushes a region of the sheet member 210 on which the probes 220 are formed so as to maintain the sheet member 210 in a flat state as shown in Fig. 1. When the probes 220 are brought into contact with the electrodes 10 on a semiconductor wafer B, the elastic member 300 absorbs elastic deformation of the sheet member 210 accompanying the contact.

[0051] A frame 400 is a member supporting the sheet member 210 and the elastic member 300 as shown in Fig. 1 and mounted to the base plate 100.

[0052] A probe sheet unit A with such a construction is mounted to the prober of a measuring instrument and used for measurement of electric characteristics of a measurement objective B. Detailed information will be given of a usage method thereof below. Note that a tester of the measuring instrument and the probe sheet unit A are connected electrically to each other through the external electrode 212.

[0053] First off, a driving apparatus for the prober is activated so as to cause the base plate 100 and the measurement objective B to move relatively close to each other. Such a movement brings the contact terminals 223 of the probes 200 and the corresponding electrodes 10 of the measurement objective B into contact with each other. Thereafter, the base plate 100 and the measurement objective B are moved close to each other to thereby press the contact terminals 223 against the corresponding electrodes 10 of the measurement objective B (that is, overdriven).

[0054] In this course, the probes 220, the sheet member 210 and the elastic member 300, or the sheet member 210 and the

elastic member 300 are elastically deformed independently of one another so as to be adapted for a dispersion in height of the electrodes 10, having various heights, of the measurement objective B to thereby absorb the dispersion.

[0055] At this time, a probe 220 is elastically deformed in a direction, upward or downward, in parallel thereto, the distal end of the second quarter circle arc portion 222 is brought into contact with the one surface of the sheet member 210 and thereafter, the distal end thereof moves on the one surface of the sheet member 210 (in a direction of an arrow mark of Fig. 2). With such a movement of the probe 220, not only is a load due to overdriving imposed on the probe 220, which has become week because of miniaturization, dispersed, but it is also possible to secure a predetermined contact pressure required for electric conductance between the probe 220 and the corresponding electrode 10 and a scrubbing distance (that is, a distance over which the distal end of the second quarter circle arc portion 222 slides on a surface of the electrode 10).

[0056] Then, after measurement of the measurement objective B with a tester ends, the driving apparatus for the prober is

activated to cause the base plate 100 and the measurement objective B to move relatively away from each other. During the course, the sheet member 210 are pushed by the elastic member 300 to restore the original position.

[0057] In a case where such a probe sheet unit A is employed, the probe sheet 220 and the sheet member 210 are elastically deformed independently of or together with each other, thereby enabling adaptation for a dispersion in height of the electrodes 10 of the measurement objective B and/or a dispersion in height of the probes 220. Therefore, since there is no chance that part of the probes is not brought into contact with the corresponding electrodes, which occurs in a conventional example., thereby enabling correct measurement.

[0058] While PCB is employed as the base plate 100, any plate member can be employed without causing a problem as far as it has a stiffness capable of enduring elastic deformation of the elastic member 300. Therefore, in a case where the above plate is employed as the base plate 100 as shown in Fig. 7, PCB is employed as the frame 400. If a design is altered this way, the wiring patterns 211 and the external electrode 212 are not required to be formed on a surface of the sheet member 210 in contact with the base

plate 100 and the elastic member 300; therefore, enabling electrical connection to the frame 400, which is PCB, with ease.

[0059] The elastic member 300 is not necessarily to be provided. That is, all of the other surface of the sheet member 210 can also be mounted so as to be adhered to the lower surface of the base plate 100. Even with a structure having no elastic member 300 in such a way, inclination and bending to a large or small extent of a measurement objective B can be adapted for by elastic deformation of the sheet member 210 and the probes 220.

[0060] Note that needless to say that the probe sheet 200 can be mounted directly to the prober without being mounted to the base plate 100.